IGHT AND LIGHTING

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Light and Lighting

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Street Lighting

Specification or Code of Practice?

THE recent I.E.S. discussion (see pp. 14-15) illustrated the benefit of comment on specifications whilst yet in course of development.

This specification is the result of a request conveyed in the Report of the M.O.T. Committee issued shortly before the outbreak of war. The need for it is officially recognised, though there are some who would prefer a "Code of Practice" and some who fear that freedom of development may be impaired by too rigid definition of performance. Standard specifications are, however, open to frequent revision. This is probably not a serious danger.

Meantime one is reminded of other recommendations in the M.O.T. Report; for example, in connection with the administration of street lighting. May we hope to see this Authority giving a lead on such matters in the near future?

I.E.S. Convention

(*May* 14-16, 1946)

From the notice which is being circulated to I.E.S. members, it will be noted that the date of the I.E.S. Convention has now been definitely fixed for May 14-16 that the meetings will be held in the lecture theatre of the Institution of Electrical Engineers, and that the Exhibition will be staged in the adjacent E.L.M.A. Lighting Service Bureau. The programme, as sketched, should be regarded as a provisional one. Much work remains to be done, but an interesting programme of papers has already been secured. Many offers of exhibits have been received; but the I.E.S. secretary is still prepared to receive suggestions of interest. Members are now being asked to record intentions of attending and to state their ticket requirements. This should be helpful in giving the organisers an approximate first idea of the probable attendance. We are asked to say, however, these returns should not be regarded as claims for tickets. Another opportunity of applying for tickets will be afforded later. In the meantime, members will bear in mind the present great difficulties in regard to catering and accommodation, which may well make it necessary to ration participation in some events, and also to appreciate the desirability of making arrangements for hotel accommodation as soon as possible.

There is one other point that we have been asked to make clear—that at evening functions morning dress will be general. This is the general understanding at the present time, and we imagine some years may pass before the full glory of evening festivities is in this respect restored.

Christmas Greetings

The card of Christmas Greetings (following the wording of the message on p. 153 of our issue for November, 1945) which was circulated to all I.E.S. members by the President was a new and enterprising step, very appropriate for the first Christmas after the declaration of peace. We notice that a somewhat similar card conveying wishes for a Happy New Year was circulated to local members by the honorary secretary of the I.E.S. Liverpool Centre (Mr. K. R. Mackley), who, with characteristic enterprise, added the words "Start it well by attending the meeting on January 2!"

I.E.S. Midland Centre

New Hon. Secretary

Mr. W. J. P. Watson (91, Brandwood-road, Kings Heath, Birmingham, 14) has now been appointed honorary secretary of the I.E.S. Midland Centre, in succession to Mr. C. J. Allderidge—to whom grateful thanks for his valuable past services are due.

Forthcoming I.E.S. Meetings

(Provisional List)

SESSIONAL MEETINGS IN LONDON

1946.

Feb. 12th. Mr. H. S. Allpress on **The Design and Performance of Industrial Lighting.** (*At the E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C.*) **6 p.m.**

Mar. 12th. Mr. G. T. Winch on **Photometric Measurements of Fluorescent Lamps.** (*In the Lecture Theatre of the Institution of Mechanical Engineers, Storey's Gate, Westminster, S.W.*1.) **6 p.m.**

MEETINGS OF CENTRES AND GROUPS

1946.

Feb. 1st. Dr. J. W. T. Walsh on **The Measurement of Light.** (*In the Imperial Hotel, Temple Street, Birmingham.*) **6 p.m.**

Feb. 1st. Mr. W. F. Perkins on **Electrical Distribution as Applied to Illuminating Engineering.** (*In the Lecture Theatre of the City of Nottingham Gas Dept., Parliament Street, Nottingham.*) **5.30 p.m.**

Feb. 4th. Mr. P. Hartill on **Illuminating and Illusion.** (*In the Electricity Showrooms, The Headrow, Leeds.*) **6 p.m.**

Feb. 4th. Mr. W. J. G. Davey on **Short Cuts in Illuminating Engineering.** (*In the Sheffield University, Western Bank, Sheffield,* 10.) **6 p.m.**

Feb. 5th. Mr. W. J. G. Davey on **Street Lighting with Special Reference to Gas.** (*In the Electricity Showrooms, Market Street, Huddersfield.*) **7 p.m.**

Feb. 5th. Mr. Imrie-Smith on **Industrial Lighting.** (*In the Liverpool Corporation Electricity Showrooms, Whitechapel, Liverpool.*) **2.30 p.m.**

Feb. 6th. Mr. T. S. Jones on **School Lighting.** (*In the Minor Hall, Oxford Street, Newcastle-upon-Tyne.*) **5.45 p.m** .

1946.

Feb. 7th. Shop Window Lighting. (*To be held at Pontypridd.*) (*Cardiff Centre.*)

Feb. 7th. Mr. W. R. Stevens on **The Trend of Fittings for Fluorescent Lamps.** (*In the Institute of Engineers and Shipbuilders,* 39, *Elmbank Street, Glasgow, C.*2.) **7 p.m.**

Feb. 7th. Mr. N. C. Hodson on **The Practical Application of the Lighting Code to the Spinning and Weaving Section of the Cotton Trade.** (*In the Reynolds Hall, College of Technology, Sackville Street, Manchester.*) **6 p.m.**

Feb. 8th. Mr. W. R. Stevens on **The Design and Characteristics of Lighting Fittings.** (*In the Heriot-Watt College, Chambers Street, Edinburgh,* 1.) **6 p.m.**

Feb. 14th. Dr. G. O. Stephens on **Fluorescence.** (*In the Bradford Electricity Department Showrooms, Sunbridge Road, Bradford.*) **6.45 p.m.**

Feb. 17th. Mr. R. Gillespie Williams on **Stage Lighting.** (*Cheltenham.*)

Feb. 20th. Mr. D. C. James on **Specialised Shop Window Lighting.** (*At the New Inn, Pontypridd, S. Wales.*) **6 p.m.**

Feb. 20th. A paper on **Street Lighting.** (*In the Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough.*) **6 p.m.**

Mar. 1st. A Paper on **Commercial Lighting** (Speaker to be announced). (*In Radiant House, Bristol.*) **7 p.m.**

Mar. 1st. Annual General Meeting and Address by the President (Mr. H. C. Weston). (*At Imperial Hotel, Temple Street, Birmingham.*) **6 p.m.**

Mar. 1st. Paper on **Fluorescent Lamp Lighting** (to be arranged). (*At Heriot-Watt College, Chambers Street, Edinburgh,* 1.) **6 p.m.**

Mar. 1st. Mr. E. W. Murray on **Lighting in Relation to Safety and Vision.** (*In the Lecture Theatre, City of Nottingham Gas Dept., Parliament Street, Nottingham.*) **5.30 p.m.**

(*Secretaries of Centres and Groups are requested to send in particulars of any changes in programmes, mentioning subject, author, place, date and time of meeting; summaries of proceedings at meetings (which should not exceed about 250-500 words) and any other local news are also welcome.*)

1946.

Mar. 4th. Dr. W. D. Wright on **Brightness.** (*At Electricity Showrooms, The Headrow, Leeds.*) **6 p.m.**

Mar. 5th. Dr. W. M. Hampton on **Glassware Manufacture with Particular Reference to the Lighting Industry.** (*In the Demonstration Theatre, City of Leicester Electricity Dept., Charles Street, Leicester.*) **6 p.m.**

Mar. 5th. Dr. W. D. Wright on **Brightness.** (*At the Sheffield University, Western Bank, Sheffield,* 10.) **6 p.m.**

Mar. 5th. Mr. W. R. Stevens on **The Design and Appraisal of Lighting Fittings with particular reference to Fluorescent Lamps.** (*In the Liverpool Corporation Electricity Showrooms, Whitechapel, Liverpool.*) **2.30 p.m.**

Mar. 6th. Mr. S. D. Lay on **Outdoor Lighting Practice.** (*In the Minor Hall, Oxford Street, Newcastle-upon-Tyne.*) **5.45 p.m.**

Mar. 7th. **" Any Questions ? " : Annual General Meeting.** (*At the Institute of Engineers and Shipbuilders,* 39, *Elmbank Street, Glasgow, C.*2.) **7 p.m.**

Mar. 7th. Mr. L. G. Applebee on **Colour and Directional Light as Applied to the Stage.** (*In the Reynolds Hall, College of Technology, Sackville Street, Manchester.*) **6 p.m.**

Mar. 7th. Mr. W. R. Stevens on **The Design and Appraisal of Lighting Fittings.** (*In the Bradford Electricity Dept. Showrooms, Sunbridge Road, Bradford.*) **6.45 p.m.**

Mar. 12th. Mr. W. R. Stevens on **The Design and Appraisal of Lighting Fittings.** (*In the Electricity Showrooms, Market Street, Huddersfield.*) **7 p.m.**

Mar. 14th. Mr. W. J. Jones on **Lighting, Past, Present and Future.** (*In the Reardon Smith Lecture Theatre, Cardiff.*) **6.15 p.m.**

Mar. 20th. Mr. R. Gillespie Williams on **The Poetry of Light.** (*At the Cleveland Scientific and Technical Institution, Corporation Road, Middlesbrough.*) **6 p.m.**

Mar. 21st. Mr. D. Jones on **Trend of Development in Fluorescence.** (*In Gloucester.*)

I.E.S. MANCHESTER CENTRE FORTHCOMING JOINT MEETINGS

In addition to the items mentioned above the I.E.S. Manchester Centre has made arrangements for the following two joint meetings with other bodies :—

1946.

Feb. 15th. Dr. W. S. Stiles on **Vision at Low Intensities of Illumination.** (*Joint Meeting with the Institute of Physics in the Large Physics Theatre of Manchester University.*) **7 p.m.**

Feb. 19th. Mr. E. C. Lennox on **Street Lighting.** (*Joint Meeting with the Institution of Electrical Engineers in The Engineers' Club, Albert Square, Manchester.*) **6 p.m.**

Photoelectric Portable Photometers

A useful British Standard Specification (667: 1945), recently issued, should be of interest to all I.E.S. members. In the introduction the liability to error of portable instruments, and especially those of the photoelectric type, is stressed. It is advised that such instruments should be returned to the makers for checking at intervals of approximately six months. The specification deals with such matters as effective range, scale and figuring, effect of temperature, colour characteristics, oblique illumination, limits of error and general design. In an appendix suitable ranges for measurements of street lighting (0.01—5 ft.c.), low and medium industrial lighting (0.5—50 ft.c.), and general industrial installations with high-level illumination (2—200 ft.c.) are specified. In a second appendix the difficult question of measurements involving large colour differences is discussed. When the variations in colour are great, makers may be asked to furnish correction factors, but the limits of error named in the specification may naturally be exceeded. Copies of the specification (price 2s. net, post free) are obtainable from the British Standards Institution (28, Victoria-street, London, S.W.1).

A Tour in the North East

In the course of a recent tour in the North Eastern Area the I.E.S. secretary, Mr. R. Pye, visited in succession the I.E.S Centres in Newcastle and Leeds and Groups in Bradford, Huddersfield, and Halifax. At Newcastle he accompanied the president, Mr. H. C. Weston, who addressed the members of the Centre in the afternoon and in the evening responded for the Society at a dinner at which nearly 100 members and guests were present, which, by general consent, was a great success. The toast of the Society was proposed by Major W. S. Milburn, M.B.E., M.C., F.R.I.B.A. president of the Northern Architectural Association, and it was a feather in the cap of the Centre to welcome this distinguished architect as their principal guest. The toast of "The Guests" was proposed by Mr. Stuart Lay, and the response was by Miss Norah Balls, J.P., chairman of the Newcastle-upon-Tyne branch of the Electrical Association for Women.

At Bradford, where Mr. A. L. Randall gave a lecture on Electric Lamp Manufacture, Mr. Pye addressed the members, dwelling particularly on the forthcoming I.E.S. Convention, and at Leeds and Huddersfield films were shown, including the one kindly furnished by the American I.E.S. dealing with industrial lighting ("Let Us See"). It was no doubt a stimulus to the various Centres and Groups to make this contact with headquarters, and we hope that the precedent will be followed in other areas. We hear very good reports of the Huddersfield Group, where matters are being conducted with energy and enterprise. Not all Centres and Groups are equally successful with local meetings. Success in this respect naturally depends chiefly on the activities of those on the spot, though perhaps it is not always appreciated what a good array of talent, from headquarters and from other centres, is now available on which to draw.

A "Film Show"

There was something out of the common in the sessional meeting held by the I.E.S. Huddersfield Group on January 15, allusion to which is made above. The meeting, which was in the nature of a "film show" and was held in the large hall of the Technical College, was organised in conjunction with the Ministry of Information, who furnished the projection apparatus and the operator. Other local scientific and professional societies were invited. Mr. Pye, as mentioned above, introduced the film prepared by the American I.E.S., "Let Us See." The next film, entitled "Your Children's Eyes," was one for which the M.O.I. were responsible, and the third film, "Looking Through Glass," was designed to illustrate the making of glassware for the table for industrial purposes, and for use in electric lamp bulbs, etc. One section of the film showed the testing of glass. In this film, incidentally, members were able to recognise Dr. Holland, the chairman of the Sheffield Centre.

The film show provided an admirable idea for filling a gap caused by the inability of Mr. F. L. Cator to lecture, but it is hoped that this event is only deferred.

A 4-ft. Fluorescent Lamp

The first of the new series of fluorescent lamps in prospect is now announced by the Electric Lamp Manufacturers' Association as being available from January 1 onwards. The lamp has a Bi-Pin cap, and is priced at 17s. 6d. The following additional particulars are given:—

Length	Colour	Voltage	Nominal Watts
4-ft.	Daylight or Warm White	200/250 A.C.	40

The Physical Society's Exhibition of Scientific Instruments and Apparatus

The first post-war exhibition of scientific instruments and apparatus arranged by the Physical Society was held on January 1, 2, and 3, at the Royal College of Science, South Kensington.

This exhibition was, before the war, an important annual event for all who were interested in the design and use of physical instruments and scientific apparatus of all kinds, and the attendance was large, increasing year by year. This, the thirtieth exhibition, however, easily beat all records, and the attendance must have been much more than double that of any previous occasion. Queues of several hundred ticket-holders waiting for admission were common, and at times the crowds round some of the more popular exhibits and demonstrations were such that it was well-nigh impossible for many visitors to hear or see what was going on.

What is to be the solution? It is, presumably, impossible for a scientific body like the Physical Society to hold an exhibition in one of the recognised exhibition halls, on account of the financial implications. The only possibility seems to be an extension of the time for which the exhibition is open. If this year is anything to judge from, a week would be all too short if the venue is to remain the Royal College of Science. Those responsible for organising the exhibition side of the Illuminating Engineering Society's Convention in May must have felt some degree of nervous apprehension as they watched the queues in the Imperial Institute-road.

The opening ceremony was performed on January 1 by Sir Stafford Cripps, who reiterated once more the now familiar statement that the place of the scientific and technical worker in the social structure should not be inferior to that of the administrator or the business man. On an occasion of this kind such a remark is, naturally, but "preaching to the converted," and one can only hope that the broadcast report of his words may have reached some, at least, of the unconverted.

Trade Exhibits

Among the many exhibits by makers of instruments and apparatus it is possible to mention only some which had a direct interest for the lighting engineer.

On the lower ground floor, Messrs. Evans, Electroselenium, Ltd., were showing a number of different types of photovoltaic cells and instruments incorporating them, including a colour tester and a reflectometer developed in collaboration with the Paint Research Station. In the same room was a new "plunger" type of colorimeter made by Messrs. Tintometer, Ltd., for the rapid and accurate comparison of the colours of solutions.

The new high-intensity flash type of lamp exhibited by Dr. Aldington, in the course of his recent address to the Illuminating Engineering Society, made its appearance on at least two stands. The "Kodatron" was shown by Messrs. Kodak, Ltd., and was stated to give, with the reflector, a luminous intensity of 100 million candles, the flash lasting about 100 microseconds. A lamp of the same general type was included among the exhibits of the Research Laboratories of the G.E.C.

Messrs. Bellingham and Stanley, Ltd., showed an improved form of their spectrophotometer, in which there was no glass between the Nicol prisms. Messrs. Chance Bros., Ltd., had a very impressive exhibit of coloured glass and of optical glass of all kinds in a variety of forms.

In the extensive exhibit shown by Messrs. Everett, Edgcumbe and Company, Ltd., there was a corner devoted to "war-time photometry." Among the instruments in this section was a "Craik" photometer, designed by the late Dr. Craik for making measurements of brightness down to the threshold of

visibility. In a room nearby, the Record Electrical Company, Ltd., were showing their street-lighting control equipment.

Research Exhibits

A room on the first floor was devoted to a very extensive and informative exhibit arranged by the Colour Group of the Physical Society. This included models and charts explaining the various systems used for colour classification There were also demonstrations of additive and subtractive colour-mixture. The principles underlying colour photography and colour printing by three-colour photogravure could be followed by means of well-arranged exhibits in which the different stages in each process were clearly shown.

The exhibit from the National Physical Laboratory was in two separated sections. That showing the work of the Light Division was in a room by itself, and here there were exhibits from the Optics Section and demonstrations of the various tests applied to different types of optical instruments. The Photometry Section showed a portable photoelectric photometer for giving a time-integration of the intensity of a varying source of light. Its range was, as regards flash duration, from a few microseconds upwards, and as regards quantity of light from 0.001 ft.c. seconds upwards. The other exhibit was of a simple galvanometer amplifier with negative feed-back, suitable for the measurement of very small photo-currents.

The stand and dark-room occupied by the Research Laboratories of the G.E.C. contained a number of exhibits of interest to the lighting engineer. Several of these were developed during the war for dealing with special photometric problems. In particular, the portable brightness telephotometer designed by the late A. E. Schuil was shown. This had a range of from 0.05 to 50,000 foot-lambents. Close by was a "disappearance range gauge" which, by means of an attachment to a pair of binoculars, enabled the visitor to increase the natural haze between himself and a distant "palm-tree" until it just disappeared. The instrument then gave the factor by which the actual range of the object should be multiplied in order to obtain the distance at which it would be found to disappear.

The polar nephelometer, described by Mr. J. M. Waldram in his recent paper before the joint meeting of the Illuminating Engineering Society and the Royal Meteorological Society, was demonstrated, and as the evening wore on, and the dust raised by the thousands of visitors got thicker, the readings obtained became higher and higher.

Mr. Winch was showing a very neat precision universal photoelectric photometer which could be either mains or battery operated, and which had been designed for precision measurement, especially of very small amounts of light. In the nearby dark room was the high-intensity flash discharge lamp, a stroboscopic lamp for the examination of fast-moving machinery, and a portable apparatus for measuring brightness distributions down to 0.03 c./sq. ft.

The Research Laboratories of the B.T.H. Company showed a large number of instruments, among them a colormeter for fluorescent lamps. It is clear that there should be a fairly high degree of standardisation in the colour of the light given by these lamps, and in the instrument shown the light from any lamp could be compared visually with a mixture of the light given by three "primary" fluorescent lamps, coated respectively with the individual component fluorescent powders.

The Discourses

As at previous exhibitions, popular discourses were given twice each day by eminent specialists in fields of scientific work of more or less general interest. On the first day, Capt. T. Martin gave a very interesting survey of the work of the optical industry during the war. On the Wednesday, Sir Edward Appleton spoke on Radar, covering much the same ground as in his lecture at the Institution of Electrical Engineers. The discourses on the third day were on the very topical subject of modern plastics and cements, and were given by Dr. J. D. Swallow. Needless to say, the large Physics Theatre of the College was filled to capacity on every occasion.

Fluorescent Tubes for the Non-Technical

by

T. C. HOLDSWORTH, F.I.E.S., A.M.I.E.E.

(Summary of Address delivered as Chairman to the I.E.S. Leeds Centre on October 1st, 1945.)

Much technical matter has been presented recently to lighting engineers, lighting trades employees, and electrical contractors, regarding the now familiar fluorescent lamp. Papers have been published in the I.E.S. "Transactions" summarising the results of highly skilled research by individual or teams of technical workers, which to a large percentage of the membership of the Society are very useful. There is, however, a section of the membership of the Society which is less able to follow expert discussion of the functioning of the lamp and gear. It is for that reason, and to assist that section, that this paper on fluorescent tubes is addressed to the non-technical.

First of all, it may be recalled that mercury-vapour lamps are not new; they were made in the last century, but their form has varied considerably. They are of three types: low, medium, and high pressure. Mercury is a metal in liquid form. The molecules of mercury are not fixed as are those of a solid, but can move and do so constantly. If a globule of mercury is placed on a dish the molecules will move freely and some will move into the atmosphere as vapour, much as molecules of water pass into the air during evaporation. If a small quantity of mercury is placed in a tube and the air from the tube is removed, we do not get a vacuum, as would occur if no mercury were present. Mercury vapour develops from the liquid, and this fills the tube up to a pressure which is entirely dependent on the temperature. Now when two electrical contacts are introduced into the tube and an electrical pressure applied, an electrical circuit is made which in one important way is similar to that of, say, a heating-element circuit. Instead of a resistor of nickel-chrome, however, mercury is used. Obviously the density of molecules is a measure of the resistance, as is the length of the path, and the current flowing is determined by this density and length.

When current flows through the mercury vapour the electrons of the current collide with the atoms of mercury. Just as "something happens" when two cars collide in a roadway, i.e., the energy released results in the damage done—so when electrons and atoms collide energy is released, and this is shown as a disturbance of the ether, that is, radiation.

Waves and Ripples

If a stone is thrown into water, ripples are created by the loss of energy on impact. The size and speed of the stone will determine the size of ripples and the wavelength, i.e., the distance between ripples. With the mercury tube and electric current, ripples are created in the ether of certain wavelengths. These ripples are called electro-magnetic waves and the whole process is called radiation.

The sun gives off vast quantities of radiation, some are utilised for vision, others for warmth, others (such as ultra-violet) are useful; others, again, are of no apparent use—at least at present.

It should be understood that these vibrations of the ether are not in themselves the effect they create. For example, the infra-red waves are those waves which on striking a suitable medium create heat. There is not a stream of heat between the radiant heater and the body being warmed—the heat is created by the vibrations inside the body as the vibrations are damped and absorbed.

Now it has been found possible to measure the "wavelengths" of these various waves and to classify them. The wavelength is the distance between the crests of adjacent waves: the frequency is the number of waves (or cycles) per second.

If it is recalled that all these waves travel at 186,000 miles, or 300 million metres, per second, the wavelength can be easily connected with the frequency, e.g., if we have a frequency of 186,000, then the wavelength is one mile; if the wavelength is 1,000 miles the frequency is 186 cycles per second and so on.

The wireless waves are generally measured in metres, so that a wavelength of 300 metres equals one million cycles, or one megacycle.

Light waves, i.e., those waves by which we see, are measured in angstrom units (Å). An angstrom unit is equal to about one 250-millionth of one inch. The light waves are between 3,800 and 7,200 Å, i.e., roughly one-sixth to one-third of one ten-thousandth of one inch.

When we speak of wireless waves we really mean that group of wavelengths which have so far been found most suitable for wireless communications, because nearly all the electro-magnetic

waves are "wireless." The eye can be considered as a radio receiver, tuned to a group of wavelengths. Other nerves respond to other wavelengths, some to heat waves, others to ultra-violet waves, etc.

Mercury Lamps

From the ordinary tungsten filament lamp infra-red and visible light waves are derived, but from a mercury vapour tube ultra-violet waves in addition; the visible light is of the peculiar colour associated with the spectrum of mercury.

The first mercury lamp was the Cooper Hewitt, operated at low pressure. Here a tube containing mercury was hinged so that the arc could be started by tilting. Some time later "medium-pressure" lamps came along; these were rich in U.V. and rather better in visible light than the Cooper Hewitt.

"High-pressure" lamps (80 watt, 125 watt, etc.) were developed a few years before the war. These have a greater efficiency in terms of visible light, but the colour-rendering qualities are still poor for some purposes. Such lamps may be used in certain industries where colour discrimination is not of great consequence and for some street lighting.

Now more about the so-called visible wavelengths. Colour may be primary or composite: white is composed of a mixture of green, blue and red in certain proportions. Mercury gives off light of a greenish blue, red being almost completely missing, and this accounts for the deathly looks we have where streets have H.P. mercury lighting.

Ultra Violet Radiation

As previously mentioned, luminescent mercury emits ultra-violet radiation, which, although quite invisible, has valuable properties. It can excite certain materials so that they themselves give off visible light. The "Black Lamp," in which glass of a special type (Wood's) filters out most of the visible and allows the U.V. to pass, illustrates this effect. When a suitable medium is contacted by the U.V. waves, fluorescence results, glowing "phosphors" or "fluorescents." Many familiar things, such as oils, teeth, pearls, etc., and metallic salts are fluorescent in some degree, the colour varying with the material. If now some red-fluorescing powder is applied to a mercury lamp the addition of the red improves the colour. Many colours can, in fact, be produced by mixing fluorescent powders.

The H.P. lamp, equipped with a fluorescent screen, was produced before the war, but a new low pressure lamp was also developed. In England, progress of manufacture was held up during the war and only one size is yet available—the 5-ft. lamp—but smaller and possibly larger lamps will certainly arrive in many colours. These lamps are fundamentally the same—a mercury discharge lamp giving much U.V. and little visible light *inside* the tube, but with little or no U.V. and lots of light *outside* the tube, owing to the action of the fluorescent powder.

About 55 per cent. of the energy used in the lamp is converted into U.V., 43 per cent. is infra red (heat) and the remaining 2 per cent. is light. The fact that the fluorescent powder makes all that difference can be readily shown by the demonstration tube which is not coated along half its length.

The Standard 5-Ft. Tube

As the 5-ft. tube is a low pressure lamp (i.e., operating at low mercury-vapour pressure) it does not start without assistance. Two filaments are arranged, one at each end, and wired in series so that the current can pass through and heat them up. These filaments are coated with barium and strontium oxides, which give off electrons very easily when heated, and these start the arc. It will be observed that attached to the filaments are two flat plates. The fluorescent lamp is used mostly on A.C., where the current reverses its direction, first one end and then the other being positive.

The flow of electrons is from the hot barium-coated filament, which is negative, to the positive end, and the plates are provided to give an easy path (a large area of landing, as it were) and also to preserve the cathode which is not emitting electrons at that instant.

It may here be mentioned that a small amount of argon gas is added to the very small amount of mercury in the tube (a few milligrams only—perhaps as much as a pin-head). Argon can conduct current at a very low voltage—and therefore starting is assisted.

When the arc has struck, it will maintain until current is switched off, so the heating of the filaments by current as at starting is not required. A switch of almost any sort will meet the starting requirement, but as the heat developed in running is produced by the running current (i.e., bombardment), further heating would shorten the life of the lamp by wasting the filament coating. An automatic cut-out is therefore fitted as a separate part of the gear.

The question most frequently put in regard to discharge lamps is: "Why

cannot they be connected directly to a supply without gear?"

Starting Switches

Let us consider the two main items, the starting switch and the choke. There are two types of starting switch. One is the glow switch. This has two terminals and looks like (and is in part) a small neon lamp. It functions first as a neon lamp, the contacts being open. In this condition the full voltage is across the electrodes, one being solid and the other bi-metal. The bi-metal electrode consists of two strips of dissimilar metal which are fused together and owing to the different expansion of the two metals it bends when heated.

The glow heats the bi-metal and it causes the electrodes to touch. This allows the lamp-heater current to flow and heat up the coated filaments. The glow having been cut out by the contacts in the glow lamp touching, the bi-metal cools and separates, and the main lamp should light up. In this condition the voltage across the starter electrodes is that across the arc—very low—and no further glow should take place. The glow switch contacts remain open until again required.

The second type is the "heater." Here we have four contacts—two for the switch (one also bi-metal) and two for a filament heater. The heater is heated all the time the current is "on." This heats the bi-metal switch (closed to start) which quickly opens—cutting off the heating in the 5-ft. tube. A small radio suppressor condenser is fitted across the switch contacts to by-pass the discharge effect, but it is not necessary for any other purpose.

The "Choke"

We now come to that bone of contention—the choke or "ballast," as the Americans call it. This fills two requirements in the starting and running of the lamp, and it consists simply of a coil of wire about a core of iron. Such a device has what is known as inductance.

Now, although a fairly low voltage (about 106 volts) will maintain the arc, it needs help to start, regardless of the argon gas and the barium coating of the filaments previously mentioned.

When a circuit having inductance is broken, the back electro-motive force is released and a surge created of much higher voltage than that of the input. This assists the arc to strike, and when the arc is struck, the choke limits the current in the circuit, because an inductance has another property, called "impedance" in an A.C. circuit. An arc in a mercury tube has a low voltage drop across it and it has the disadvantage that as the current *rises*, the voltage across it *falls*.

This will be readily understood on consideration. At first the tube is cool. Only a limited number of mercury atoms are vaporised and the paths available to electron streams are few. The resistance is therefore relatively high. As the heat increases, so the vapour density increases and, additional paths being available, the resistance drops. An increase in current takes place with consequent further heating until, if the fuses do not blow, the lamp will burst. The choke resists such changes directly and limits the flow to normal.

The need for a definite limit to the current taken implies that the choke must be fairly accurate in its operation. This also explains why one choke will not do for more than one lamp. Further, when other than 5-ft. tubes are available, the chokes will vary with the size of the lamp. In the United States of America lamps consuming from 6 watts (9-in. by ⅝-in. diam.) up to 100 watts (5-ft. by 2⅛-in. diam.) are in use.

It has been the practice until fairly recently to furnish the choke with several tappings to suit any of the various supply voltages. More recently, however, makers of certain fittings have been supplying untapped chokes. The supply voltage should, therefore, be specified in such cases, because the lamp voltage is fairly critical.

Effect of Power Factor

Partly owing to the inductance of the choke but also owing to the arc, a fluorescent lamp has a very poor "power factor"—the current is out of step with the voltage. As an electricity meter only registers that current which is in step with the voltage, the supply authorities are placed at a disadvantage. The current actually lags at about 60 per cent., which means that the peak current is behind the peak voltage by about 1-300th of a second. Condensers are, therefore, generally supplied to correct this, because they cause a current to lead its voltage, and exercise a compensating effect. This might cause a considerable loss of revenue to supply undertakings when these lamps become more or less universal, unless power-factor correction is practised. The lamp takes 80 watts and is sold as such, an additional 10

watts are absorbed by the choke, and where a thermal switch is used, about two more watts are dissipated.

Stroboscopic Effects

The current provided by most supply authorities is alternating, usually at a frequency of 50 cycles per second. The pressure builds up from zero to a maximum, drops to zero and repeats the process in the opposite direction, all in one-fiftieth of one second. In the case of a tungsten filament lamp the heat created in the filament has not time to dissipate between the pulsations and flicker is hardly discernible. With the mercury tube, on the other hand, the arc commences only when the pressure is nearing its peak and stops when it is nearly down to zero. This takes place each half-cycle, so that we actually have one hundred flashes of light per second. It is an interesting point that from a 100-watt tungsten lamp the loss of light due to the frequency may be 6 per cent., but the loss in a daylight fluorescent tube may be 55 per cent. This fluctuation may give rise to the so-called stroboscopic effect which may be something of a nuisance, particularly where moving parts are illuminated. For instance, if a wheel with 50 teeth is turning at, say, two revolutions per second, it would appear to be virtually stationary. Such a condition is not often found but it needs consideration. One way of minimising the trouble is to connect alternate lamps to different phases of the supply, but as a two- or three-phase supply is not always available, it may be simpler to use more condensers and create a leading current in one tube and a lagging one in another. Condensers so used may be in series or parallel with the lamp.

Some fluorescent powders, particularly the red ones, are more retentive than others, that is, they continue to glow for an appreciable time after the excitation has been removed. This "phosphorescent" property assists materially in preventing the stroboscopic effect, and it is likely that as time passes improvements in this direction will enable the flicker to be entirely eliminated.

The operation of these lamps on direct current has not yet been mentioned. In this case, besides a choke, a resistor is necessary which absorbs about one-half the total wattage and a glow switch must not be used. There is no stroboscopic effect as the arc is continuous, but blackening of one end takes place rather quickly. To avoid this the lamp can be changed round each day or polarity reversed in some other manner.

Guiding Rules

The average life of a fluorescent tube is now accepted as over twice that of a filament lamp, and this to some extent compensates for the otherwise rather high initial price. Now the war is really over, the fluorescent lamp will become more and more the light in general use both in industry and the home.

There are a few points, however, regarding the installation and servicing of these lamps which should be remembered. These are:—

(1) The choke should be connected on the live (not neutral) side of the lamp, so that if a fault develops on the lamp or wiring the choke will at any rate limit the flow of current and prevent damage to starter.

(2) When a lamp fails to light, the fault may be due to one or more of several causes, and care should be taken to ensure that a new lamp is not installed until it is reasonably certain that the gear is not faulty.

(3) A faulty starting switch is possible but unlikely. The life of a switch is probably many thousand operations.

(4) When a tube flickers in and out it is most likely nearing the end of its life, and in any case should be disconnected as soon as possible, otherwise damage to the starter will occur.

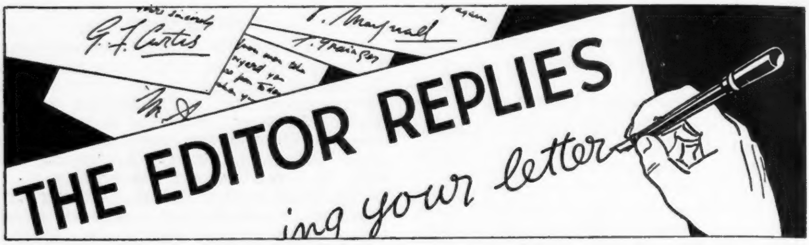
(5) A point not readily appreciated with regard to the tappings on the choke is this, that with, say, a 200-V. supply and using the 210-V. tapping, a smaller current will flow, not a larger. Similarly, with a 210-V. supply and a 195- or 200-V. tapping, the current will increase to the detriment of the lamp life.

(6) An ammeter should be used if possible to check the current, which should be about 0.8 amp. if a faulty choke is suspected.

(7) Reversal of lamp or rotation through 180 degrees may assist in prolonging the life of a tube in an emergency, but it is not economy to try to extend the life when flickering occurs.

(8) Particularly where a fitting is earthed, care should be taken to avoid shocks as the momentary pressure at starting may be as high as 800-V.

(9) The output of a lamp drops from about the equivalent of a 200-watt to that of a 150-watt tungsten lamp during the first 100 hours' use, due principally to the contamination of the powders by the mercury. An allowance should therefore be made in calculations and in comparisons of running costs.



I have received some correspondence in regard to the point raised by Mr. A. R. McGibbon last month—the specification of **Values of Artificial Illumination** intended to **Supplement Daylight.** In so far as the artificial illumination is merely intended to reinforce natural illumination, for example, in the parts of a room most remote from the window as daylight diminishes during a winter afternoon, the position stated in our last issue seems fair enough. Values of artificial illumination as stated in the I.E.S. Code should then form a very substantial improvement, and are recognised by the eye as such.

But I confess the position is somewhat different when one has to think of **the disturbing influence of daylight**—i.e., to consider how far value of artificial illumination provided in a factory by night may no longer appear adequate under daylight conditions. At first sight it may seem absurd to fear that the addition of daylight in a room may result in people seeing less well, but in practice the condition does sometimes arise.

It must always be remembered that although natural light from a white sky has such great advantages the entrance of such light through a skylight or window may prove to have great drawbacks—sometimes giving rise to definite glare, but more often depressing vision owing to **"reversed contrast."** In extreme cases in partially blacked out factories local shafts of sunlight or even bright daylight may be positively dangerous because of their dazzling effect. A more usual experience, however, is the depressing effect of bright windows facing the workers. Mr. E. W. Murray sends me a copy of his excellent paper on Factory Lighting and Accident Prevention (Trans. Illum. Engg. Soc., London, Jan., 1937) in which instructive instances are quoted. One instance was that of certain power presses where the natural lighting in the gangways was actually a hundred times that on the working area. The difficulty was accentuated by the fact that the workers had to **look through power press guards,** the brightness of which was very much greater than that of the work.

Such cases evidently call for remedy, either by readjustment of the daylight conditions or by the provision of extra artificial illumination locally, but it is evident that one could hardly prescribe for all such eventualities in the Code. Inspectors of factories, so often viewing things on the spot, are the people best able to detect such weaknesses and suggest remedies—but they, naturally, have plenty of other pressing claims on their vigilance.

I had recently the pleasure of a visit from Mr. Aksel Bagh, an **I.E.S. member resident in Denmark.** He was able to give me in the main a reassuring picture of his country, where it should not prove very long before the pre-war agricultural prosperity is restored. Denmark, however, has beeen cut off from knowledge of lighting developments during the war period. Mr. Bagh was keenly interested not only in the fluorescent lamps but also in the super high pressure mercury vapour lamps and other "bright light sources" such as those described by Dr. Aldington in his recent paper.

Mr. Bagh also mentioned, as a curiosity, the views of someone in Denmark

who is a **fanatic for yellow light,** believing apparently that vision has much to gain by the use of yellow screens. Some readers will recall similar claims made by foreign scientists before the war—which actually led the Dutch Government to pass a measure requiring the general use of yellow headlights. There seems as little ground for this belief as for the contrary view still occasionally expressed, that our eyes are being ruined by the excess of yellow rays in the spectra of artificial illuminants!

Professor H. Cotton has kindly sent some pages from his forthcoming book in which he discussed domestic lighting. He lays stress on one factor not sufficiently taken into account in judging lighting installations, the **"sense of well-being."** There is no doubt that during periods of leisure most people still incline towards a "warm" light, though it may be true that judgment in this respect is affected by the order of brightness provided. Whilst for high level lighting fluorescent lamps in white or "off white" colours may be acceptable, Professor Cotton doubts the expediency of retaining these tones for the **smaller sizes of lamps,** for which **yellowish,** or even **pinkish, tints** may be preferred. He concludes by suggesting that "fluorescent lamps should not be regarded as the solution of any and every problem."

With the coming **release** of many young men **in the Forces** there is naturally some concern about their absorbtion in the lighting industry and the chances of **satisfactory employment** in the immediate future. It is my own belief that the ultimate prospects should be good, considering the immense leeway that is to be made up in the lighting field—practically all sections except industrial lighting having been virtually at a standstill for so long.

There may, however, be a somewhat difficult intermediate period whilst firms are feeling their way. The chief openings are still those with firms actually engaged in the lighting industry, but there is some ground for hope that this is a passing phase, and that, ultimately, the field for employment may be widened.

I have always believed, for example, that not only Government Departments and Public Authorities but also **large industrial concerns** ought to find it possible to employ **at least one expert** solely on lighting technique. There are some signs of progress in this direction. An instance that occurs to mind is the engagement of Mr. Stuart Lay, a leading member of the I.E.S. Newcastle Centre, as lighting expert by the Courtauld interests. With congratulations to Mr. Lay and good wishes in this new work one may couple the hope that other large concerns will show similar enterprise. Certainly it would be all for the good of the I.E.S. to have in its ranks a larger proportion of lighting experts who hold independent positions of this nature.

The British Standard Specification for Street Lighting*

(Notes on a discussion at the I.E.S. Sessional Meeting held in London on January 8th, 1946.)

A brief review of the British Standard Specification for Street Lighting had been presented at the recent meeting of the Association of Public Lighting Engineers. It was felt, however, that another opportunity, with more time for discussion, should be afforded. The I.E.S. accordingly arranged a meeting in London, to which members of the A.P.L.E. were invited.

The introductory review of the specification was again in the hands of Dr. J. W. T. Walsh, who was followed by Mr. F. C. Smith and Mr. J. M. Waldram, both of whom had likewise been intimately concerned with the drafting of the specification in its present form.

Dr. Walsh commenced by presenting a sketch of the historical background, recalling especially the original specification (No. 307), based on horizontal "test point" illumination. The next important event was the Report of the M.O.T. Committee (1937), which divided roads into two main classes and, after outlining general conditions to be met, went on to urge the need for a formal standard specification. A committee was therefore assembled, but in 1939, owing to the outbreak of war, had to abandon their task, which was not resumed until about a year ago. They had to consider two conflicting points of view, of those who desired a specification and of those who preferred something wider in the nature of a "code of practice." Ultimately, however, it was agreed to proceed with a specification which dealt firstly with Class A roads. The draft specification was divided into three parts. Part I. dealing with mounting heights, spacing, overhang, etc., was mandatory. A feature was the clause dealing with the effect of lanterns on the road, and referring to tests of lanterns both in the laboratory and conducted on the road—on which a tremendous amount of work was done by Mr. J. M. Waldram and Mr. F. C. Smith. Part II of the specification was more like a code of practice, and Part III contained clauses dealing with the maintenance of the installation. The draft had been described as suffering from "appendicitis," and, in fact, there were three appendices, the first explanatory, and the second and third dealing respectively with siting sources on bends and with the "directional intensity ratio."

Mr. F. C. Smith, who followed, referred specifically to that rather mystic quantity which made appearance in the specification, the "acceptance number," which was not a criterion of excellence but rather a "go or not go gauge." In this connection Mr. Smith pointed out which specific quantities were under the control of the lighting engineer, and explained in some detail the considerations that had led to the framing of the maintenance clause—a task of considerable difficulty.

Mr. J. M. Waldram explained that his task had been particularly to deal with the test clause and the laboratory work involved. He recalled the frequent request for a test of visibility or "revealing power," an exceedingly difficult thing to achieve in a specification. The tests devised by the sub-committee, if not directly ensuring visibility, did secure a fairly good installation, and provided for three different types of distribution, viz., the cut-off type, the non-cut-off type, and the semi-cut-off type, each associated with a particular kind of arrangement and spacing. In conclusion, Mr. Waldram urged

* Copies of this draft specification (CH (ELG) 1524) may be obtained on application to the British Standards Institution, 28, Victoria-street, London, S.W.1.

that lantern design was not an easy process; therefore a very rigid specification was not desirable.

Dr. S. English, in opening the discussion, contended that the acceptance number was in fact a figure of merit. An installation with a figure of merit twice as big as another was not necessarily twice as good, but it would certainly be considered better. He urged that the specification, whilst intended to be so framed as not to "cause prejudice to the future development of the art of street lighting," did, in fact, impose very definite restrictions, for example, in the defining of polar distribution. He would have preferred a code of practice which would have enabled a lighting engineer to design an installation with complete freedom. In conclusion, he urged that attention should be given to Class B roads, and also to intermediate roads.

Mr. T. Wilkie urged that requirements in regard to maintenance should be more explicit, e.g., there should be some period mentioned for the cleaning of glassware and burners. The erection of poles in many areas was not within the hands of the lighting engineer; nor was the nature of the road surface on which the results of the installation greatly depended.

Mr. Cunnington feared that the specification might limit pioneer work on street lighting fittings, on which much remained to be done. The specification should not refer too rigidly to any special type of lantern, and he showed a lantern slide illustrating an unusual arrangement of spacing which had definite advantages.

Parliamentary and Scientific Committee

Fifth Annual Luncheon

There was a very distinguished gathering indeed for the fifth annual luncheon of the Parliamentary Scientific Committee, which took place at the Savoy Hotel (London) on January 30.

The toast of "The Guests" was proposed by the Rt. Hon. Viscount Samuel (President of the Parliamentary Scientific Committee), whilst the toast of the Committee itself was proposed by the Rt. Hon. Herbert Morrison. Mr. Morrison was at his happiest on this occasion, paying generous tribute to the value of science in the national life and emphasising the need for free and unchecked effort on the part of young scientists, in whose hands the future of this country so largely rested.

There were approximately 300 present, and anyone familiar with the representative character of the Parliamentary and Scientific Committee, and its broad ramifications, will appreciate that many eminent men in the scientific and political world were present.

The value of science in daily life has often been emphasised. In this Committee we have an organisation capable of most valuable effort on behalf of science, fit to serve as a bridge between scientific thought and practical affairs. The Illuminating Engineering Society some years ago gladly accepted the opportunity of joining the list of affiliated bodies. Its representative at executive meetings is Dr. J. W. T. Walsh, and its representative at the annual general meeting, Dr. H. Buckley, both eminent past presidents of the Society.

On the occasion of the luncheon, the Society was represented in the persons of its president (Mr. H. C. Weston) and its secretary (Mr. Raymond Pye).

Australian I.E.S. Transactions

As we go to press it is learned that the United Illuminating Engineering Society of Australia are now publishing "National Transactions," reviewing the activities of all the three constituent bodies. A National Council, acting on their behalf, is to be formally inaugurated in October.